Organized and Sustainable or Chaotic and Dying? Data Needed to Quantify Conditions and Monitor Change

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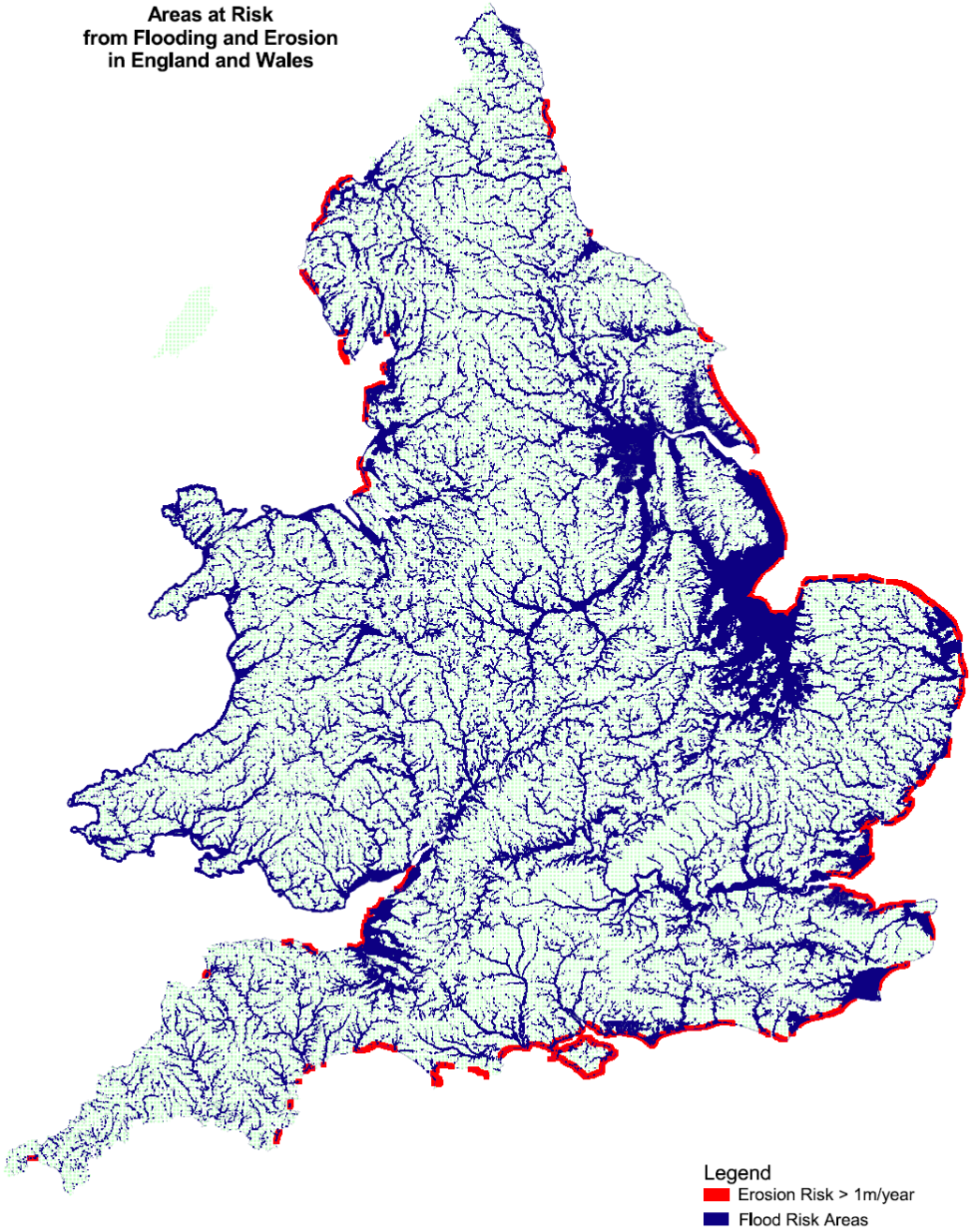
Outline

From '*Chaotic and Dying*' to '*Organized and Sustainable*':

- Considerable advantage can be gained from innovative application of existing datasets
- Precise data is not necessary for all applications and data at different levels of detail can be combined effectively
- Data gap identification and informed data collection evolve from adaptive planning
- Clear definition of program objectives ensures data collection efforts yield maximum benefit
- National and strategic assessments deliver considerable benefits for sustainable risk management decisions on the coast

Background: The UK Coast

The Coastline of England and Wales



- 3000 km in length
- 1000 km fronts 2200 km of land below the level of the highest tide
- Another 1000 km is at risk of loss by erosion
- Approximately 90% of these areas at risk are protected by human intervention

Increasing Funding Requirements

- We already need to spend twice that currently just to maintain the levels of protection already provided
- With Sea Level Rise, the relative cost of coast protection in England and Wales by year 2080 will be a further 2 to 4 times that today

Scenario / Cost	Without climate change	Low emissions	Medium-low emissions	Medium-high emissions	High emissions
Relative increase in cost *	100%	150%	190%	280%	370%
Funding needed to provide existing protection	today x2		= today x4		= today x8

Costs all at current day prices *(* after Burgess & Townend, 2004)*

UK Framework

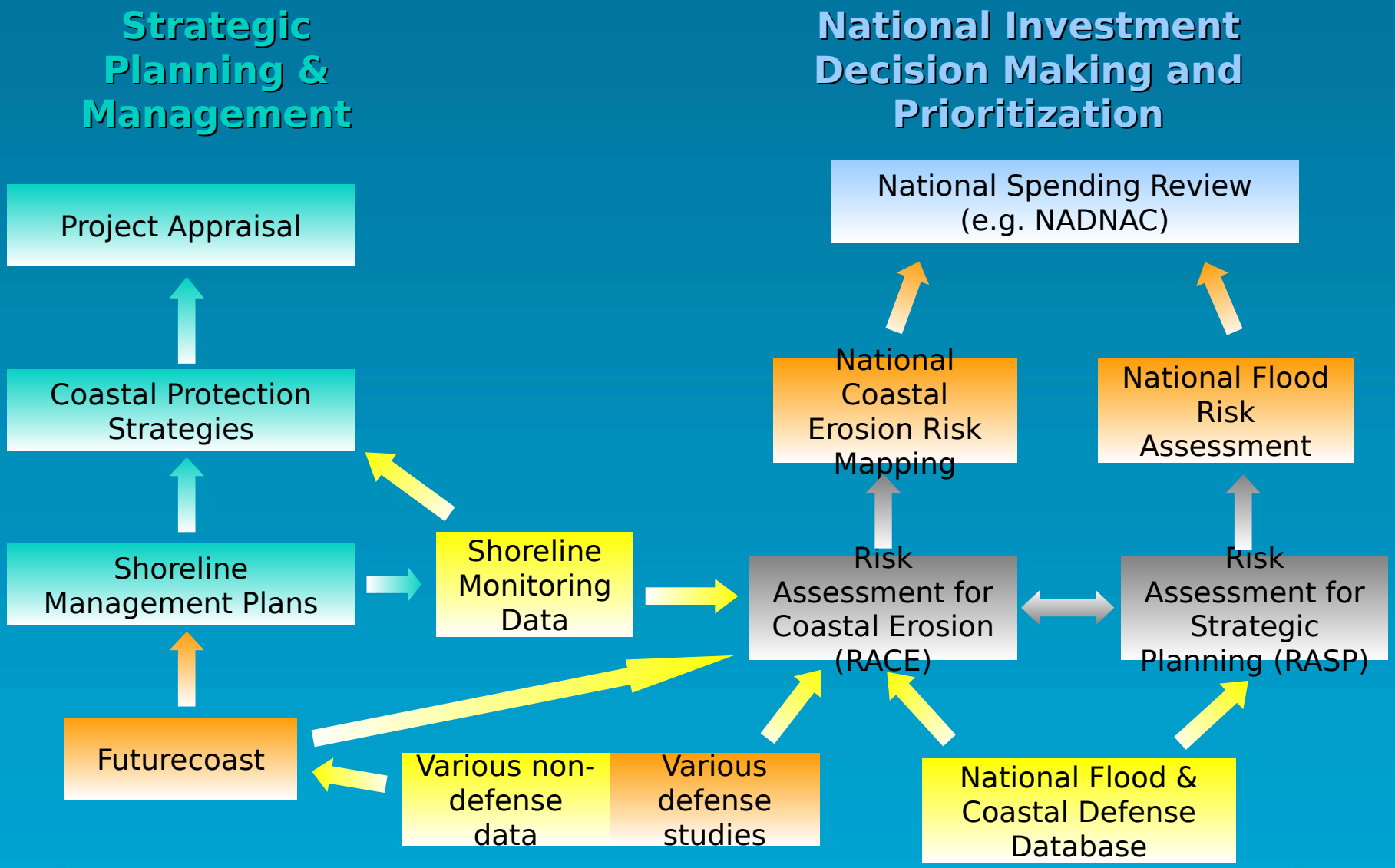
Chaotic & Dying legacy

- Over 90 different operating authorities with responsibility for coastal protection
- Several lacked the knowledge or skills required to participate in a strategic approach.
- No history of authorities working together on coast protection
- Adopting solutions that tackled their own problems but failing to appreciate impacts on others.
- No consistent data collection and analysis by authorities

Development of the UK Framework

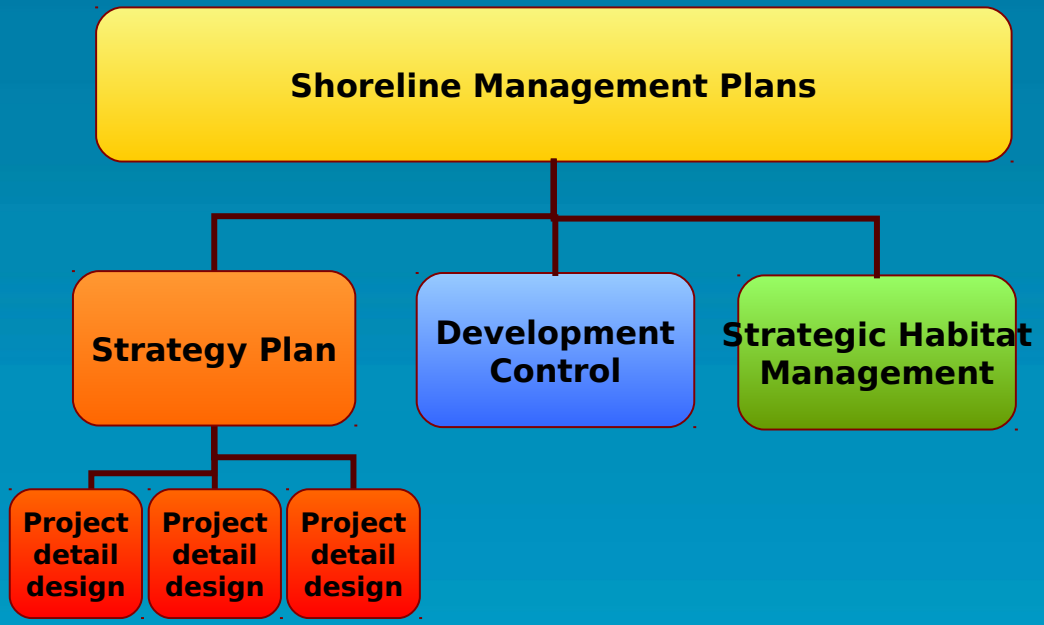
Date	Strategic Planning	National Studies
1987	Anglian Sea Defence Management Study	
1990		National Sea Defence Survey & Coast Protection Survey of England
1995	Shoreline Management Plans (SMPs)	Identification of coastal flood risk (ABI)
		Government Spending Review
2000	Review of SMPs	National Appraisal of Assets at Risk
	Guidance for 2nd Round SMP's (SMP2)	National Flood Risk Assessment
2005	Pilot SMP2's	National Appraisal of Defence Needs and Costs
	SMP2's (ongoing)	Futurecoast
		Foresight
2009		National Coastal Erosion Risk Mapping

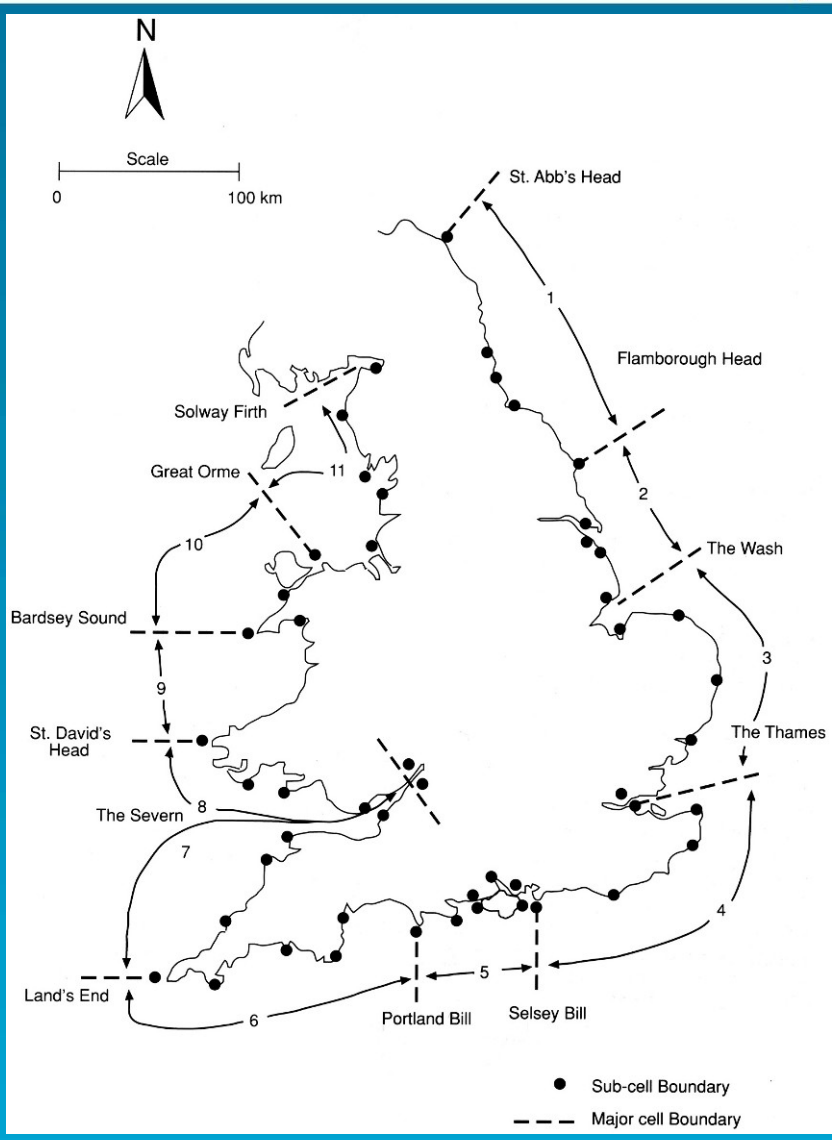
Tools and data to enable



Shoreline Protection: Strategic Planning & Management

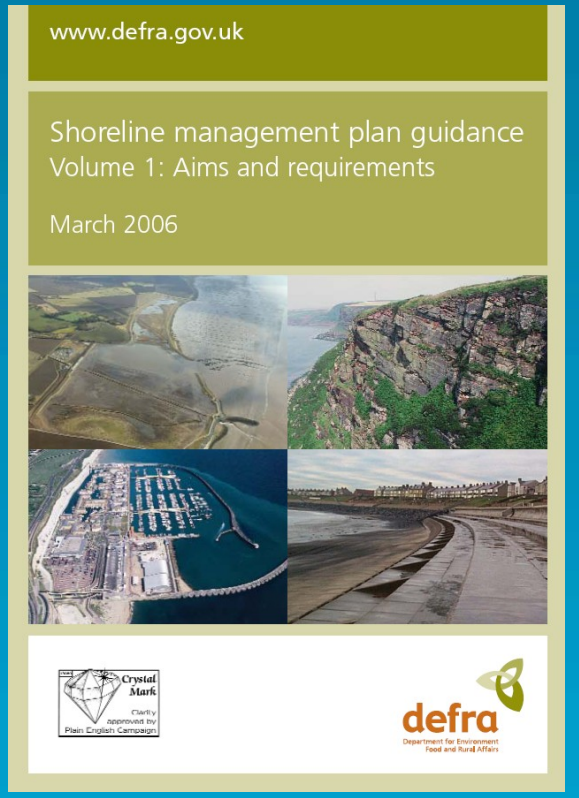
Organized & Sustainable Future





Shoreline Management Plans

- **Aim to identify sustainable, adaptive policies to manage flood and erosion risks**
- **Consider 20, 50 and 100-year time steps**
- **Utilize data on present day form and function of coast, projected future evolution, and human/natural coastal resources**
- **Integration of approaches to risk management, including:**
  - land use
  - development planning
  - flood protection works
  - flood warning and emergency response
- **Inform research and monitoring**
- **Reviewed every 5-10 years**



SMP Data Collection

National Datasets (from EA, EN, Defra):

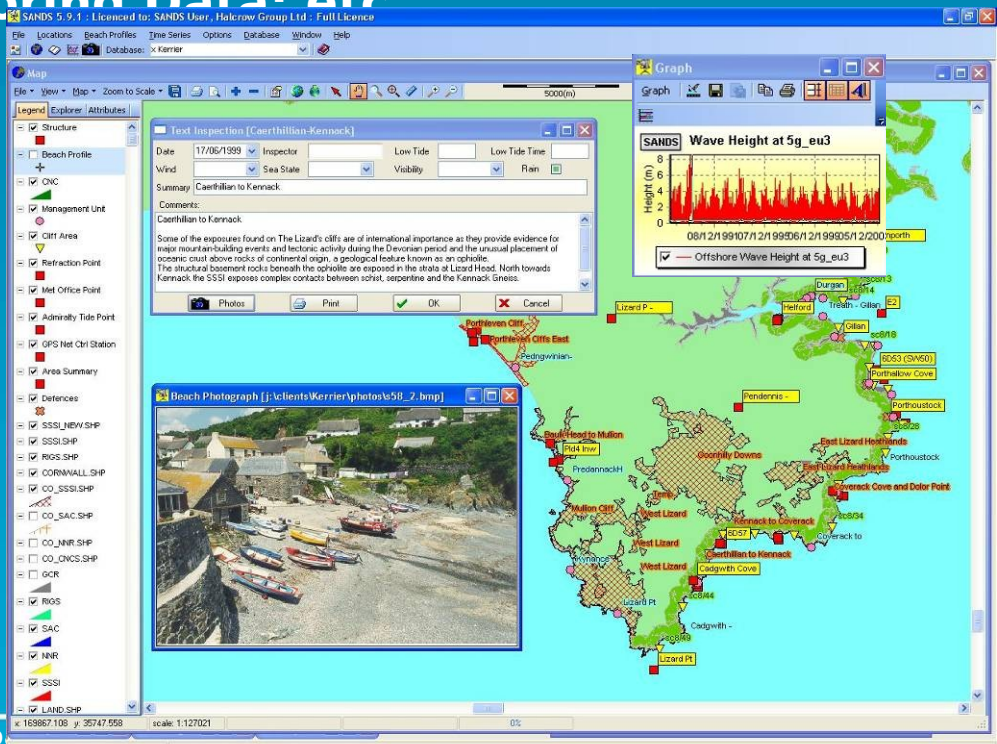
- **Conservation designations; property locations; land use; etc**

Regional/Local (various sources):

- **SMP1; Strategies; Projects; Process/other studies; Planning documents; Monitoring Data; etc**

New data collection is not part of the Plan.

Utilize what's available and define needs for next iteration: adaptive planning



Risk Based Data Collection

Topographic Surveys:
- Baseline survey every 1 or 5 years at 50m spacing.
- Twice-yearly interim profile surveys at spacing's of 100m to 500m.
- Annual post-storm surveys at each site, for half of the interim profiles

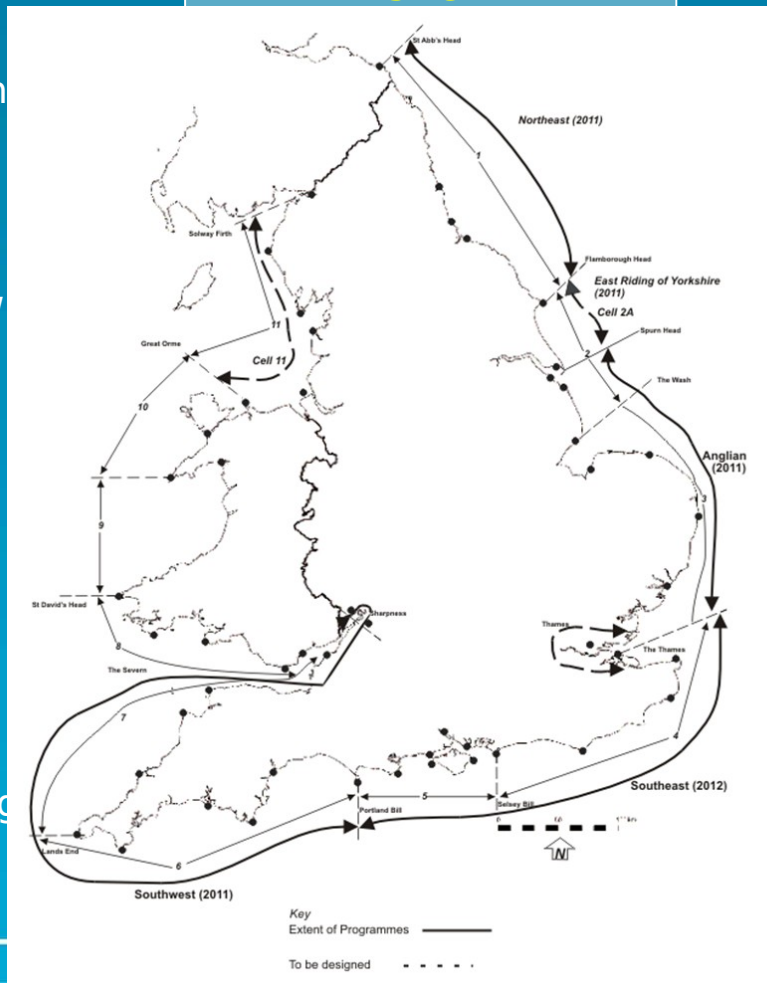
Items in yellow: spacing/frequency determined by appraised 'risk' at site.

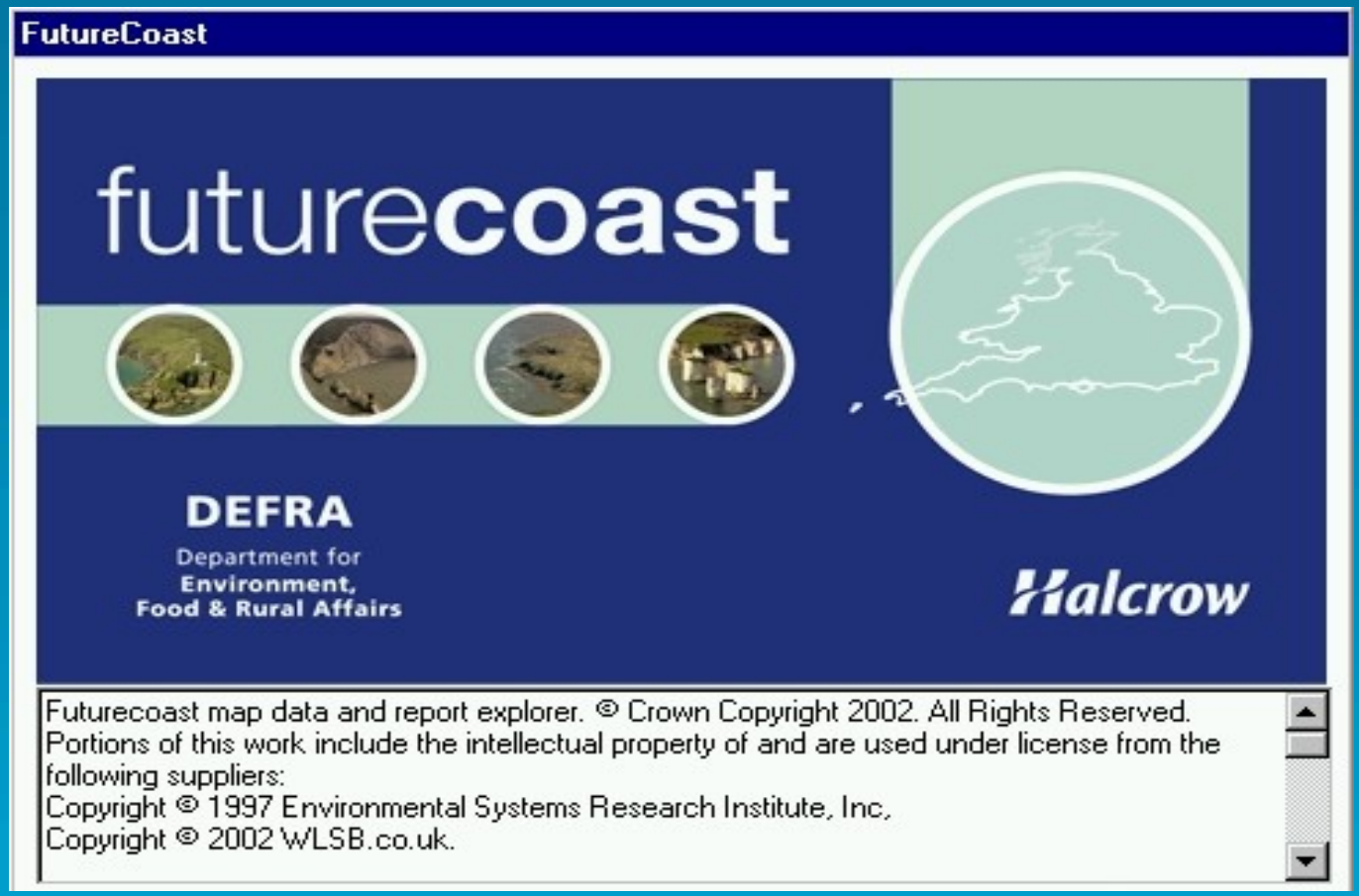
Bathymetry:
- One survey every 5 years for the whole of the coastlin
- Extends to 500m or 1000m offshore
- Lines spaces at 50 – 100m

Wave Buoys / Tide Gauges:
- 11 wave buoys in the SE programme (and 7 in the SW
- 5 tide gauges, in addition to existing gauges

LiDAR:
- Collected every 1 to 5 years
- Data are collected at 1m resolution
- LiDAR are used to geo-rectify aerial photography

Aerial photography:
- Collected at about the same frequency as LiDAR
- Currently have a resolution of 0.1m
- Infra-red photography captured to aid habitat mapping

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Assessment of Future Geomorphic Evolution

Potential tendency (unconstrained)

The shingle ridge would roll back across the low-lying hinterland with rising sea levels, exposing basement sediments presently on its landward side to marine action. Due to the limited availability of contemporary sediment input, the ridge could begin to segment, exhibiting localised swash-aligned tendencies and could breakdown, with sediment being dispersed along the shoreline.

Ultimately, the ridge would roll back to meet the fossil cliff line, enabling marine action to re-activate processes of recession within these features.

Predicted behaviour with present management practices

The present seawall precludes the above natural

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Linked reports

View Report

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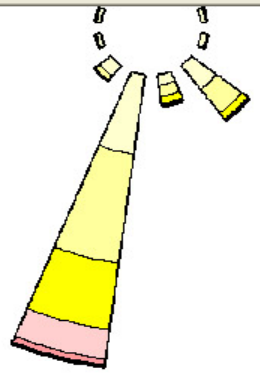
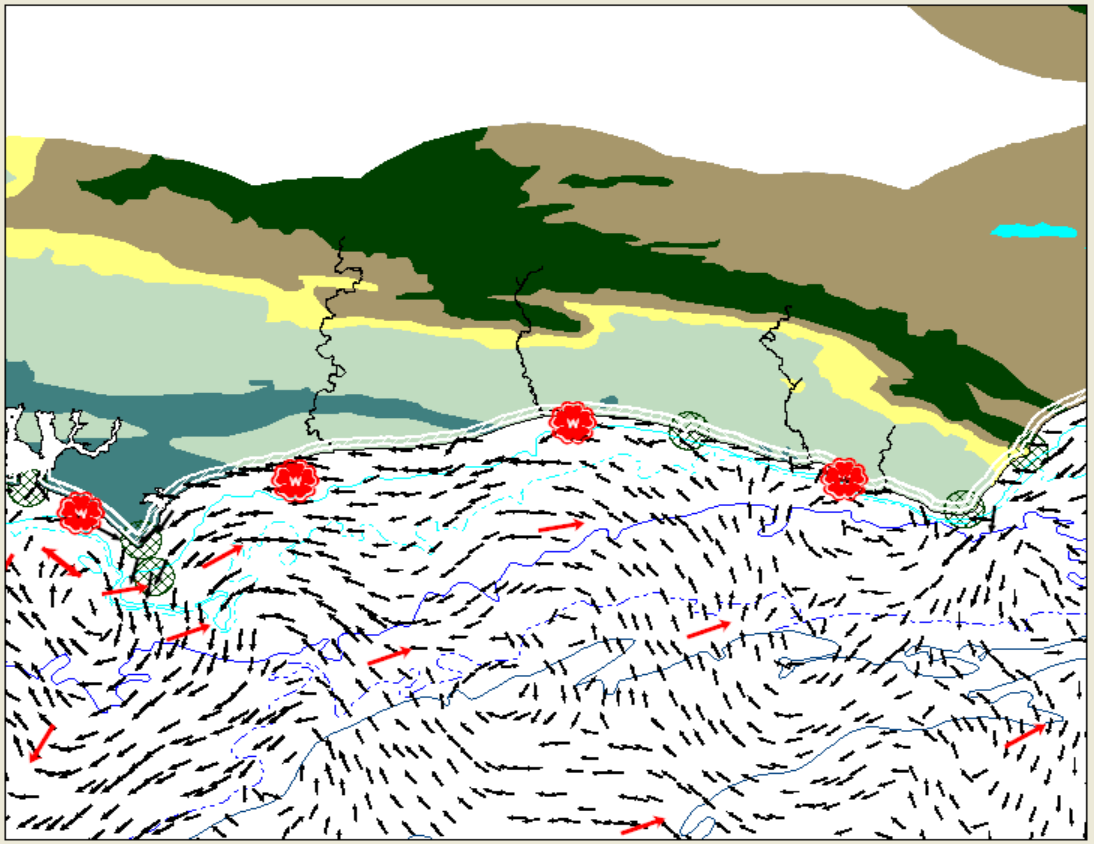
Map Library 1 (1:500,000 scale)

- Offshore Sediment Movement
  - suspended sediment
  - bedload sediment
- Tidal Residuals
- Tidal Ellipses
- Inshore Wave Points
  - inshore wave point

Information pane | Gazetteer | Locator



SCALE BAR IS 10% OF DATA



Linked reports

Coastal Processes: Beachy Head to Selsey Bill

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Framework Reports
Data & Supporting Information
Cliff Behaviour Assessment
Shoreline Movement Assessment
Nearshore Wave Analysis
Uncertainty Assessment
Coastal Geomorphology Reference Manual
Supplementary Bibliography
Glossary
Thematic reports
Onshore Reports
Offshore Reports
Process Reports
Macro Review of Coastal Processes
Introduction
Bathymetry
Tides
Waves
Surges
Non-Tidal Currents and Overall Circulation
Sediment Transport
Summary of Large Scale Hydrodynamics
Summary of the Characteristic Properties of
References
East Coast Process Review
South Coast Process Review
Approach
Overview of Processes
The Offshore Zone
The Nearshore Zone
Introduction
North Foreland to Beachy Head
Beachy Head to Selsey Bill
Selsey Bill to Hurst Spit
Isle of Wight (IoW)
Hurst Spit to Durlston Head
Durlston Head to Start Point
References
West Coast Process Review
Estuary Reports
Review of Climate Change & Sensitivity
Interpretive reports

Beachy Head to Selsey Bill

Characteristics and internal constraints

The coastal morphology is composed of cliff, beach and estuary units. The estuaries along this coastal stretch are; Pagham Harbour; and the estuaries of Arun, Adur, Ouse, and Cuckmere. The nearshore sediments are predominately sands, although further offshore gravelly sand and gravel are characteristic. Exposed bedrock on the seabed is located on the western flank of Beachy Head. The coast is shown to be accreting at the harbour mouths (e.g. Pagham Harbour; Brand *et al.,* 1995) and undergoing erosion at the shingle beaches.

External forcing

The dominant wave directions are from the south-south-west and south-west. The annual 10% exceedance significant wave height is 1.5 to 2 m. The coastal orientation means that the lee of Selsey Bill is protected from these waves.

The tidal currents are typically weak in the bays and strong at the headlands. Residual tidal currents show divergence in the vicinity of Pagham Harbour, such that an anti-clockwise eddy is located directly to the east of Selsey Bill. The mean tidal range is 4.3 m at Shoreham.

Sediment transport

The control of the waves upon the sediment transport results in a net easterly drift between Selsey Bill and Beachy Head. A local convergence zone occurs at the mouth of Pagham Harbour, with an anti-clockwise circulation of sediment present further offshore. This results from tidal current interference from the harbour, which also causes a divergence zone to the east of Pagham Harbour. Intermittent onshore movement of shingle is also indicated from offshore points between Selsey Bill and Beachy Head (Brand *et al.,* 1995). The estuaries of Arun, Adur, Ouse, and Cuckmere have represented fine-grained sinks throughout the late Holcene.

Selsey Bill to Hurst Spit

Characteristics and internal constraints

The Solent represents the drowned remnants of the ancient Pleistocene Solent River, whilst Southampton Water and its linked estuaries (Test, Itchen and Hamble) represent a major tributary of this river.

This section of the coastline is characterised by shingle beaches, cliffs and ebb tidal deltas. Three natural harbours are located within this sub-section; Chichester, Langham and Portsmouth. An interesting feature is Bracklesham Bay, which represents a logarithmic spiral bay (ABP Research, 2001). The only prominent zone of accretion within this region is in the lee of Hurst Spit. Mobile sediment takes the form of both sand and shingle. The major offshore feature here is the Bramble Bank, a large sandy area north of Cowes.

The seabed sediments are predominately gravelly sand/sandy gravel although exceptions occur seaward of Chichester Harbour, which is predominately sandy, and between Warsash and Gilkicker Point, which is sandy mud/muddy sand.

External forcing

Due to protection of the IoW and Hurst Spit, there is a low energy wave climate in this area which is fetch limited although local exposure from southerly gales can be expected. Refraction also becomes important in this area (HR Wallingford, 1993). Tidal currents are strong, especially in the entrances of the Solent's major inlets. Hence, tidal currents primarily control sediment transport. Of the tidal currents, the ebb tide typically predominates over the flood. The headland of Selsey Bill protrudes into the tidal flow causing flow separation and the generation of an offshore

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Historic Movement

Profile Lines

historic measurement location

Historic Shoreline Movement

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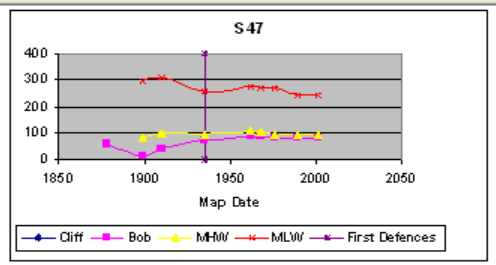
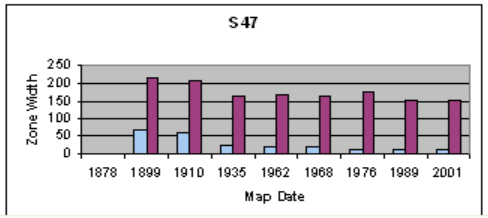
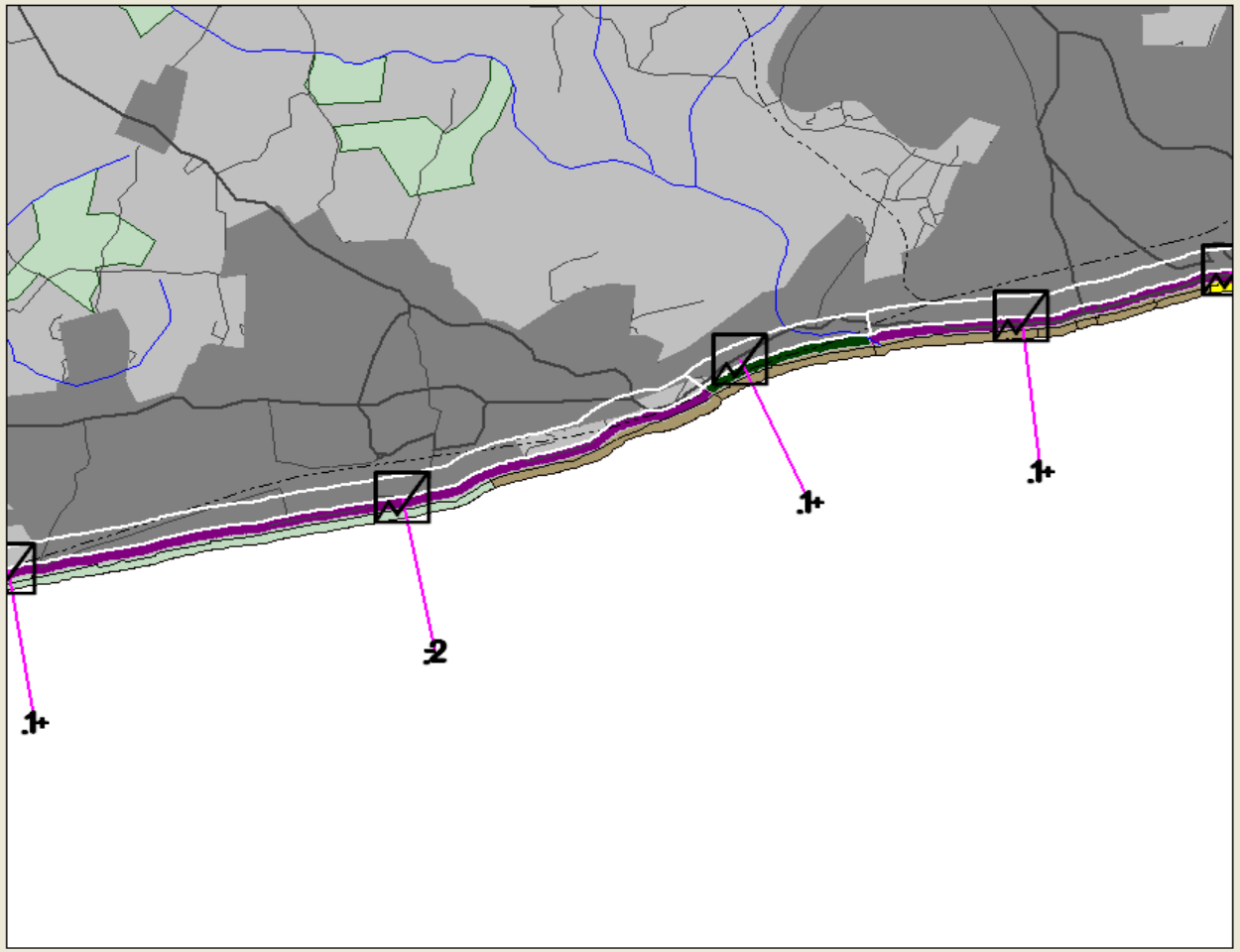




SBS: Cliff End to Beachy Head
CBS: Straits of Dover (North Foreland to Beachy Head)



Linked reports

CBS Report: Straits of Dover (North Foreland to Beachy Head)

View Report

CBS Report: Straits of Dover (North Foreland to Beachy Head)
SBS report: Cliff End to Beachy Head
Local Scale Shoreline Response Statement: LSRS: Bexhill
Historic Shoreline Movement: Cliff End to Beachy Head

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    - Shoreline Movement Assessment
    - Nearshore Wave Analysis
    - Uncertainy Assessment
    - Coastal Geomorphology Reference Ma
    - Supplementary Bibliography
    - Glossary
  - Thematic reports
    - Onshore Reports
    - Offshore Reports
    - Process Reports
    - Estuary Reports
    - Review of Climate Change & Sensitivity
  - Interpretive reports

Sandgate to Cliff End : Future U

Large-scale evolution

1. There is a deep, infilled bay extenc Hythe/Sandgate, following the lin cuspate foreland system fronting a bay forming between Cliff End an and Sandgate.

2. The western end of the Pett Levels of roll back with rising sea levels a limited sediment supply. Combine distribution of existing sediment e natural tendency between Rye Har

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Sandgate to Cliff End
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Offshore
Onshore geology
Estuaries
Uncertainty
Cliff classification
Historic Mapping Shorelin

Assessment of Future Geomorphic Evolution

Potential tendency (unconstrained)

Without wider-scale management intervention, the sand foreshore and shingle barrier would naturally continue to receive sediment input (even, ultimately, including some from west of Beachy Head) but only in very small volumes. There would, however, continue to be the longshore drift of material from the frontage to feed downdrift sediment stores. Consequently, this would lead, over time, to a sediment deficit, breaching of the barrier, and its eventual breakdown.

In combination with the foreshore response, the barrier would roll back across the low-lying hinterland in response to rising sea levels. The rate of roll back would depend upon the rate of sea level rise, the inertia of the barrier, and the topography of the hinterland. The potential for progressive segmentation and ultimate breaching of the barrier would be high, and such events would result in the inundation of the backshore and the creation of a new tidal inlet. The timescale within which this is likely to naturally occur would probably be within the next century.

Predicted behaviour with present management practices

Sediment recycling operations and the presence of a seawall effectively fix the present plan-form position of the shoreline and prevent barrier roll back with rising sea levels. Over time, this will result in the managed plan-form position of the barrier not being commensurate with its natural position within the tidal energy frame. This could

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Map Library 3 (1:50,000 scale)

Future Shoreline Change (With Present Management)

Future Shoreline Change

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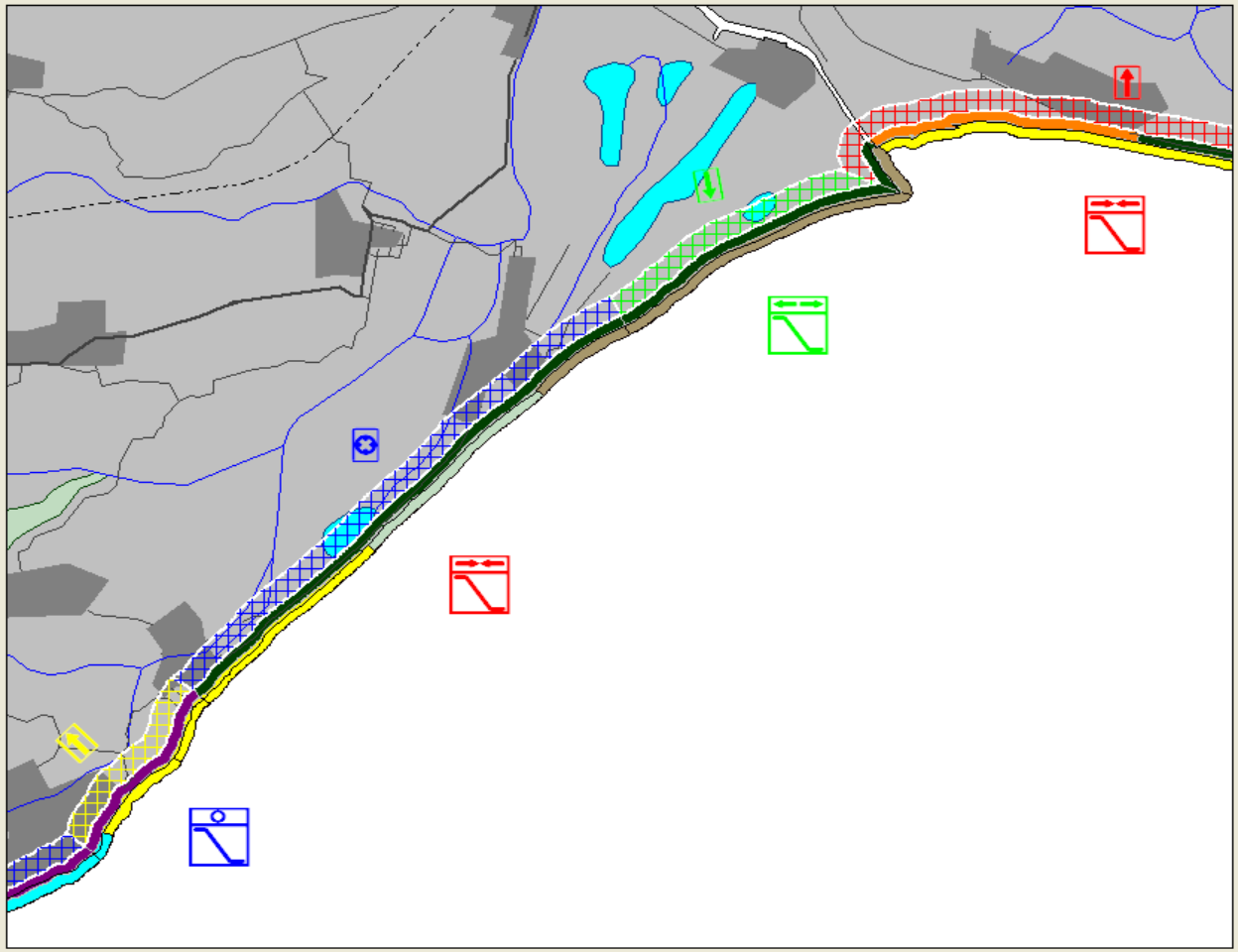

Information pane | Gazetteer | Locator

Camber Sands

Future Foreshore Change: foreshore narrowing

Details on local scale shoreline response are provided within the 'Assessment of Future Geomorphic Evolution' section of the Local-scale Shoreline Response Statements. The uncertainty associated with this prediction is provided within the Uncertainty Assessment report. Both of these can be accessed directly from this map window.

SBS: Sandgate to Cliff End
CBS: Straits of Dover (North Foreland to Beachy Head)

Linked reports

CBS Report: Straits of Dover (North Foreland to Beachy Head)

View Report

CBS Report: Straits of Dover (North Foreland to Beachy Head)
SBS report: Sandgate to Cliff End
Local Scale Shoreline Response Statement: LSRS: Camber Sands
Uncertainty: Sandgate to Cliff End
Historic Shoreline Movement: Sandgate to Cliff End

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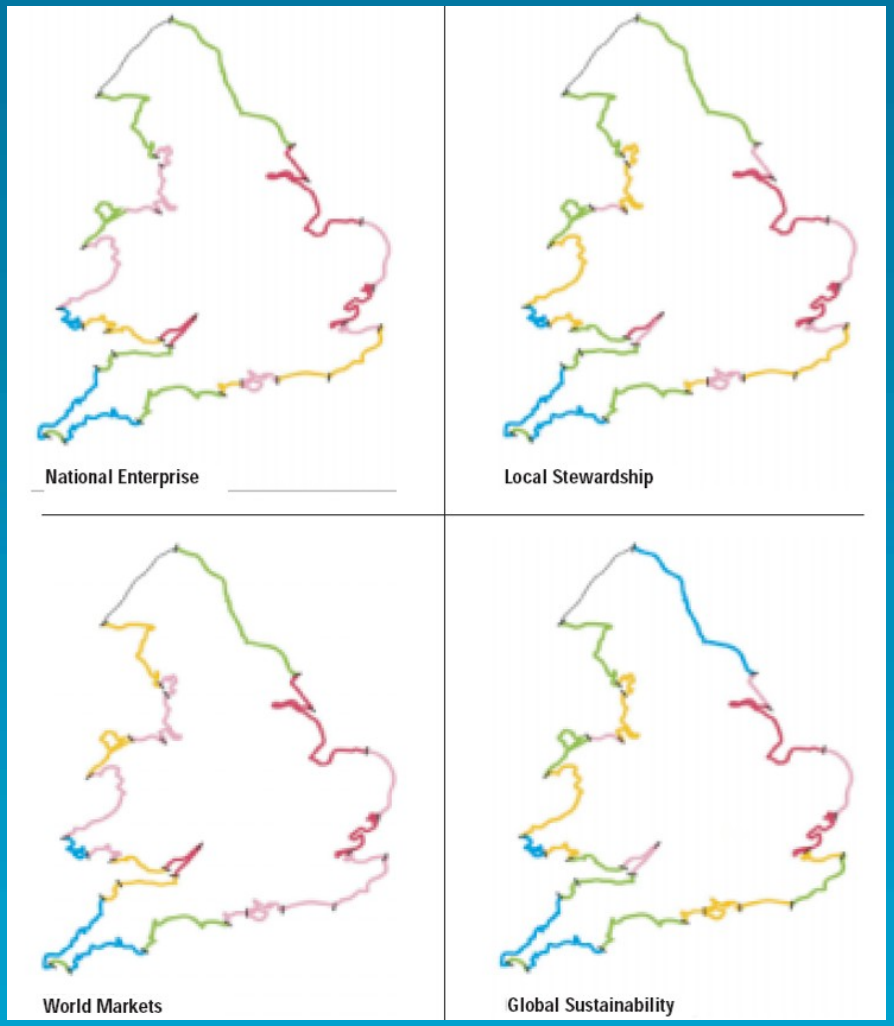
Foresight: Future Coastal Change

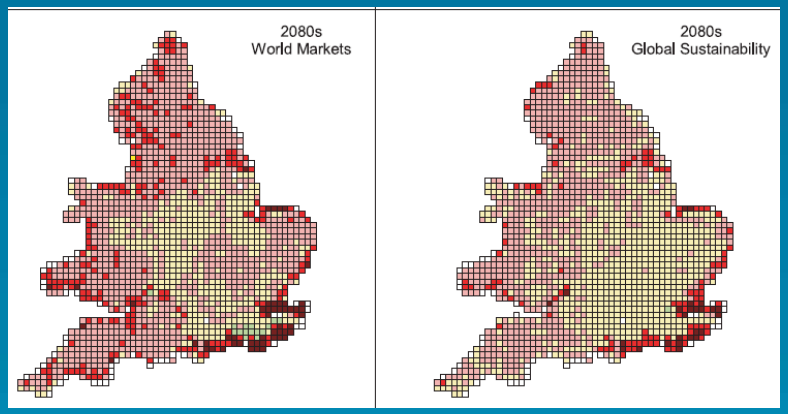
- Futurecoast analyses provided the inputs for coastal erosion projections for ‘Foresight’
- Futurecoast projections applied to 4 ‘futures’
- Used Futurecoast to develop some case studies for different coastal types

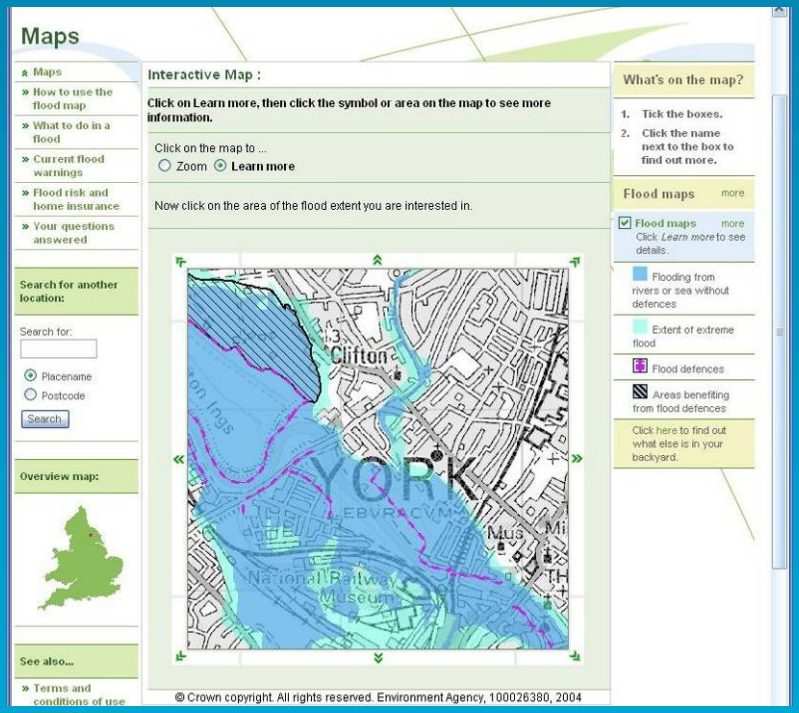
- Broad assessment of the economic impacts of significant coastal change *(Middlesex Univ)*



Coastal Risk Assessment for Prioritization

Application of National Assessments





- Inform policy and decision making
- Robust scientific analysis to justify budget allocations/requests.
- Risk management progress reporting
- Prioritization decisions
- Project development
- Drive ongoing data collection and analysis efforts
- Consistent national risk mapping (public access)

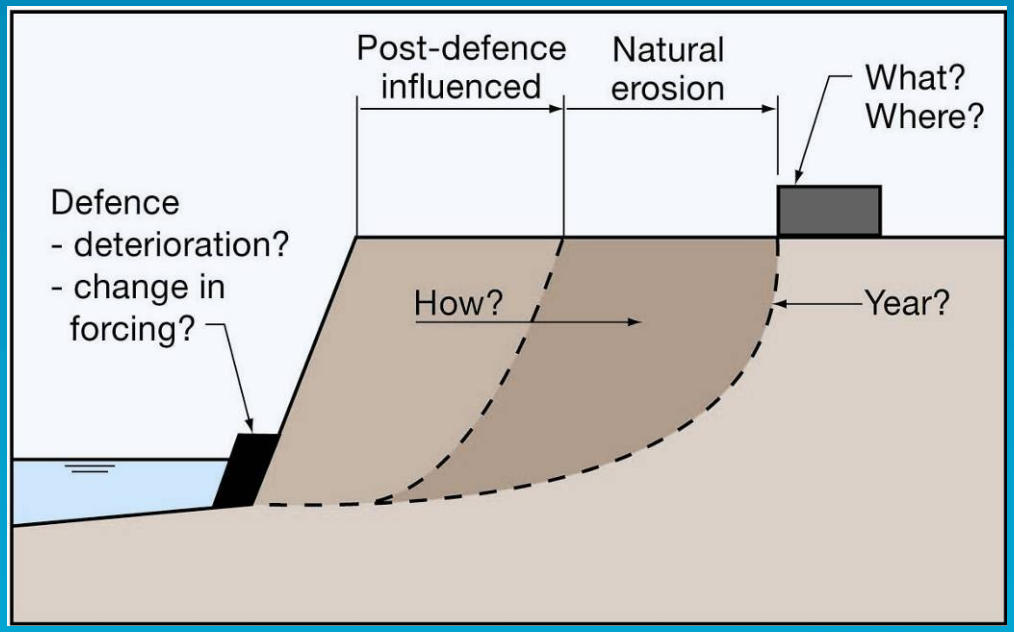
National Appraisals

- **National review of needs and priorities - does not require precise input data or outputs**
- **Consistency of analysis within and between regions is critical**
- **Early studies adapted available datasets and developed new analytical techniques to deliver study goals**
  - e.g. structure failure from; form, condition, failure mode, beach material
- **Assign confidence based on data available**
- **Collate and adapt available 'asset' data to determine risks**
- **Informed the definition of 'ideal' data required for this analysis; has evolved over iterations**
  - e.g. toe elevations, materials, beach slope, etc
- **The National Flood and Coastal defence Database (NFCDD) has evolved to drive these studies**

Coastal Erosion Analysis

For each component of the system we need to answer a series of questions:

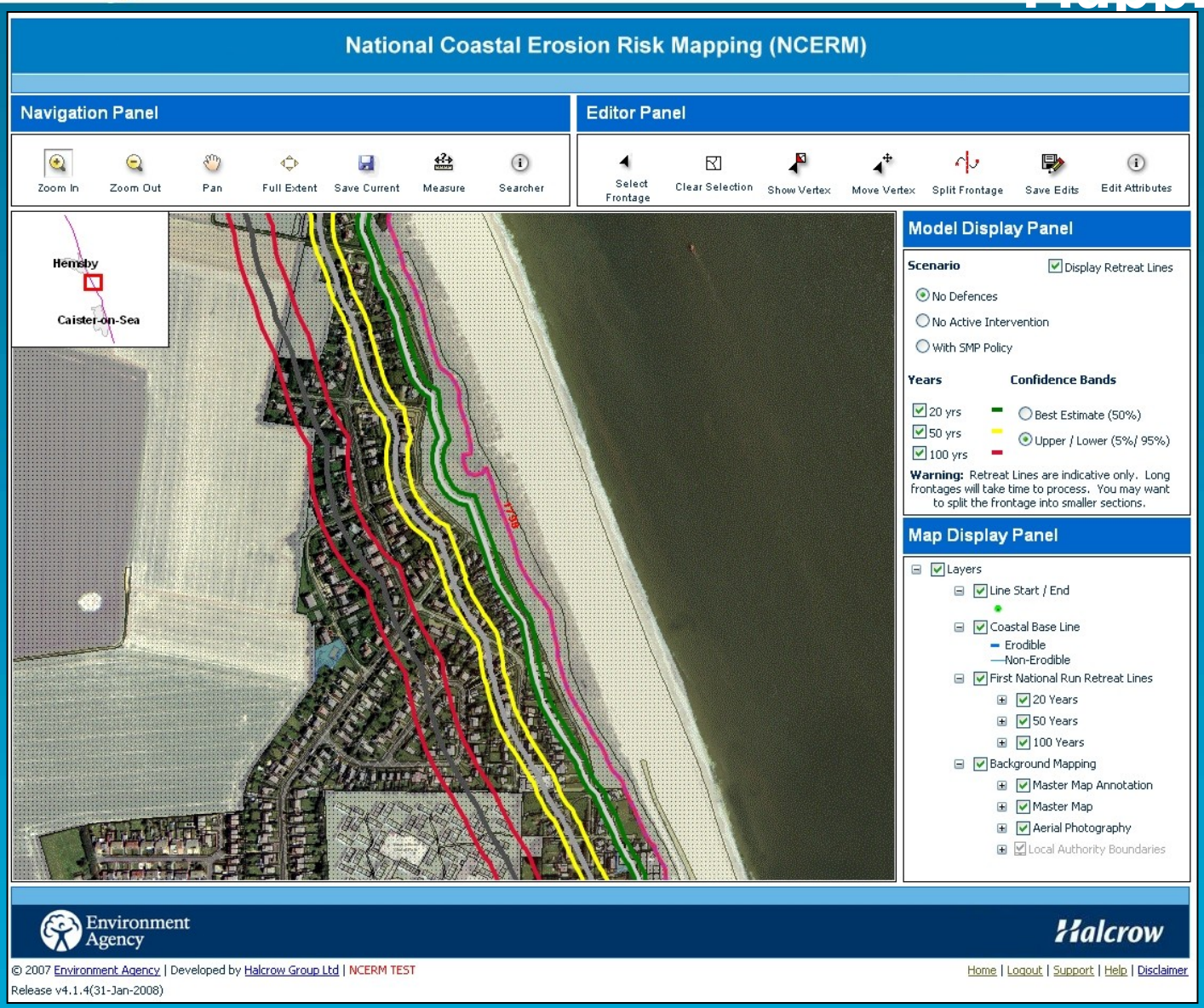
1. What is the mechanism for erosion? How fast will this occur?
2. How long and by how much will any intervention delay this process? What is the mechanism for intervention to fail? What is the annual likelihood of this occurring?
3. What assets are there? Where are they?



Protection Structure Analysis Techniques

Technique		General Description	Main Points
1	Engineering Judgement	Experienced based assessment for use with minimal data.	Quick and easy method. Crude approximation.
2	Qualitative Assessment	Uses qualitative data from the National Flood and Coastal Defence Database (NFCDD) to apply indicative tests.	Consistency of available data lends itself to national application. Imprecise output.
3	Broad Numerical Analysis	Combines physical information from NFCDD with data from other sources (e.g. beach levels and general wave/water level conditions)	More accurate than Technique 2, although some aspects remain imprecise. Can be coded to deliver national level application.
4	Detailed Calculation of Failure Potential	Calculation of stability, overtopping undermining etc with good knowledge of the structure and forcing conditions.	Very robust methods which deliver reliable results. Data requirements exceed Techniques 1 to 3. Some LAs may already have such studies readily available.
5	Probabilistic Models	Detailed analysis of failure mechanisms and interactions of each structural component	Likely to provide most accurate output. Methods require extensive data and expert input.

National Coastal Erosion Risk Mapping



Concluding Remarks

From '*Chaotic and Dying*' to '*Organized and Sustainable*':

- Evolving planning processes drove innovative application of existing datasets to deliver new understanding
- Precise data is not necessary for all applications and data at different levels of detail can be combined effectively
- National and regional approaches to prioritizing can use disparate input data
- These studies have identified critical data gaps and informed data collection programs
- Clear definition of program objectives ensures data collection efforts yield maximum benefit
- National and strategic assessments deliver considerable benefits for sustainable risk management decisions on the coast

THANK YOU!

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Email: hoskingas@halcrow.com